



Radioactivity in the Risø District July-December 2012

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Radioactivity in the Risø District July-December 2012

The cover design features a large rectangular area on the left with a grid of squares in shades of blue and green. A vertical red bar is positioned on the left side of this grid, containing the text 'DTU Nutech Report' in white. To the right of the grid is a solid light green rectangular area.

DTU Nutech Report

Sven P. Nielsen, Kasper G. Andersson and Arne Miller
DTU-Nutech-R-0005(EN)
June 2013

DTU Nutech
Center for Nuclear Technologies



Author: Sven P. Nielsen, Kasper G. Andersson and Arne Miller
Title: Radioactivity in the Risø District July-December 2012
Division: Radiation Research

DTU-Nutech-R-0005(EN)
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Abstract (max. 2000 char.): The environmental surveillance of the Risø environment was continued in July - December 2012. The mean concentrations in air were: $0.32 \pm 0.31 \mu\text{Bq m}^{-3}$ of ^{137}Cs , $3.04 \pm 0.99 \text{ mBq m}^{-3}$ of ^7Be and $0.22 \pm 0.18 \text{ mBq m}^{-3}$ of ^{210}Pb (± 1 S.D.; $N = 26$). The depositions by precipitation at Risø in the second half of 2012 were: 0.039 Bq m^{-2} of ^{137}Cs , 615 Bq m^{-2} of ^7Be , 40.3 Bq m^{-2} of ^{210}Pb and $< 0.6 \text{ kBq m}^{-2}$ of ^3H . The average background dose rate (TLD) at Risø (Zone I) was 54 nSv h^{-1} compared with $58 \pm 8 \text{ nSv h}^{-1}$ (± 1 S.D.; $N = 3$) in the four zones around Risø.

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Table 1. Radionuclides in ground level air collected at Risø (cf. Figs. 1, 1.1 and 1.2), July - December 2012. (Unit: $\mu\text{Bq m}^{-3}$)

Date	^7Be	^{137}Cs	^{210}Pb
02-Jul-12 – 09-Jul-12	3006	0.131	159
09-Jul-12 – 16-Jul-12	2315	0.103	82
16-Jul-12 – 23-Jul-12	3656	0.103	103
23-Jul-12 – 30-Jul-12	5139	0.271	264
30-Jul-12 – 06-Aug-12	3990	0.117	168
06-Aug-12 – 13-Aug-12	5266	0.318	244
13-Aug-12 – 20-Aug-12	3330	0.244	202
20-Aug-12 – 27-Aug-12	3683	0.147	164
27-Aug-12 – 04-Aug-12	4645	0.142	227
04-Sep-12 – 10-Sep-12	3041	0.117	118
10-Sep-12 – 17-Sep-12	3913	0.161	271
17-Sep-12 – 24-Sep-12	2550	0.242	168
24-Sep-12 – 01-Oct-12	2554	0.140	151
01-Oct-12 – 08-Oct-12	2014	0.161	84
08-Oct-12 – 15-Oct-12	2734	0.176	234
15-Oct-12 – 22-Oct-12	2761	0.362	417
22-Oct-12 – 29-Oct-12	1421	0.264	152
29-Oct-12 – 05-Nov-12	2021	0.320	292
05-Nov-12 – 12-Nov-12	2114	0.175	418
12-Nov-12 – 19-Nov-12	2848	0.398	955
19-Nov-12 – 26-Nov-12	2608	0.694	88
26-Nov-12 – 03-Dec-12	3352	0.382	146
03-Dec-12 – 10-Dec-12	1900	0.494	88
10-Dec-12 – 17-Dec-12	3035	0.698	321
17-Dec-12 – 24-Dec-12	1858	1.628	93
24-Dec-12 – 31-Dec-12	3372	0.251	190
Mean	3043	0.317	223
SD	986	0.313	177

Table 2.1. Radionuclides in precipitation in the 10 m² rain collector at Risø (cf. Fig. 1), July - December 2012. (Unit: Bq m⁻³)

Month	⁷ Be	¹³⁷ Cs	²¹⁰ Pb
July	4967	0.497	321
August	2387	0.155	136
September	1712	0.059	106
October	1230	0.056	92
November	1243	0.044	52
December	1613	0.122	131

Table 2.2. Radionuclides in precipitation in the 10 m² rain collector at Risø (cf. Fig. 1), July - December 2012. (Unit: Bq m⁻²)

Month	Precipitation (m)	⁷ Be	¹³⁷ Cs	²¹⁰ Pb
July	0.029	144	0.0144	9.3
August	0.039	93	0.0060	5.3
September	0.067	114	0.0040	7.1
October	0.072	89	0.0040	6.6
November	0.045	56	0.0020	2.3
December	0.074	119	0.0090	9.7
Sum	0.326	615	0.0394	40.3

Table 2.3. Tritium in precipitation collected at Risø (cf. Figs. 1, 2.3.1 and 2.3.2). July - December 2012. (Unit: kBq m⁻³)

Month	10 m ² rain collector*
July	2.2
August	< 1.7
September	< 1.7
October	< 1.7
November	< 1.7
December	< 1.7
Double determinations*.	

Table 2.4. Tritium in precipitation collected at Risø (cf. Fig. 1). July - December 2012. (Unit: kBq m⁻²)

Month	Precipitation (m)	10 m ² rain collector
July	0.029	0.064
August	0.039	< 0.066
September	0.067	< 0.114
October	0.072	< 0.122
November	0.045	< 0.077
December	0.074	< 0.126
Sum	0.326	< 0.569

Table 3.1. Radionuclides in sediment samples collected at Bolund in Roskilde Fjord.(cf. Fig. 3.1) July - December 2012. (Unit: Bq kg⁻¹ dry)

Date	¹³⁷ Cs	K*
1 July	2.4	16.6
*Unit: g kg ⁻¹ dry		

Table 4.1. Radionuclides in seawater collected in Roskilde Fjord (cf. Fig. 4.1) July - December 2012. (Unit: Bq m⁻³)

Date	¹³⁷ Cs
1 July	10.9

Table 4.2. Tritium in seawater collected in Roskilde Fjord (Risø pier) (cf. Fig. 4.2) July - December 2012.

Month	kBq m ⁻³
July	< 1.7 *
August	< 1.7 *
September	1.7 *
October [#]	-
November [#]	-
December	< 1.7 *
* Double determinations	

[#] starting autumn 2012, tritium in seawater is measured quarterly.

Table 5.1. Radionuclides in grass (snow) collected at Risø (near the Waste Treatment Station (cf. Fig. 1)), July - December 2012. (**Measured on bulked ash samples)*

Week no. or month	Date	K (g kg ⁻¹ fresh)	¹³⁷ Cs (Bq kg ⁻¹ fresh)	¹³⁷ Cs (Bq m ⁻²)
27	2 July	5.0	<0.3	
29	16 July	5.3	<0.5	
31	30 July	4.8	<0.3	
33	13 August	9.9	<1.1	
35	27 August	3.9	<0.6	
37	10 September	6.4	<0.5	
39	24 September	5.7	<0.8	
41	8 October	5.5	<0.9	
43	22 October	4.7	<0.4	
45	5 November	4.4	<0.4	
47	19 November	2.8	<0.2	
49	3 December *	< 0.1	<0.2	
51	17 December *	< 0.1	<0.2	
**July		5.4	0.039	0.018
**August		6.4	0.121	0.022
**September		6.3	0.103	0.029
**October		5.2	0.063	0.011
**November		3.6	0.044	0.020
**December		2.1	0.220	0.046

Table 5.2. Radionuclides in Fucus vesiculosus collected at Bolund in Roskilde Fjord. July - December 2012. (Unit: Bq kg⁻¹ dry)

Date	¹³⁷ Cs	K*	% dry matter
1 July	3.4	29	18
*Unit: g kg ⁻¹ dry			

Table 7.1. Waste water collected at Risø (cf. Fig. 1), July - December 2012.

Week number	eqv. mg KCl l ⁻¹	¹³⁷ Cs (Bq m ⁻³)	¹³¹ I (Bq m ⁻³)	²²⁶ Ra (Bq m ⁻³)
27	85	< 72	< 71	< 140
28	84	< 109	< 108	< 207
29	73	< 105	< 110	< 216
30	74	< 106	< 109	< 213
31	122	< 111	< 116	< 217
32	163	< 115	< 116	< 224
33	130	< 111	< 114	< 211
34	115	< 101	< 110	< 201
35	117	< 111	< 110	< 225
36	123	< 107	< 111	< 223
37	142	< 111	< 113	< 213
38	148	< 99	< 106	< 202
39	160	< 106	< 115	< 204
40	147	< 74	< 175	< 154
41	136	< 110	< 109	< 209
42	175	< 116	< 118	< 223
43	149	< 100	< 106	< 204
44	211	< 110	< 113	< 205
45	181	< 122	< 120	< 237
46	143	< 107	< 107	< 203
47	113	< 103	< 112	< 202
48	159	< 112	< 113	< 230
49	108	< 116	< 115	< 221
50	109	< 101	< 114	< 205
51	118	< 107	< 109	< 209
52	79	< 83	< 175	< 239
Mean	129.4			
SD	34.8			

Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period May - October 2012. (Results are normalized to nSv h^{-1})

Location	nSv h^{-1}
1	54
2	42
3	40
4	55
5	50
6	55
Mean	49

Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period May – October 2012. (Results are normalized to nSv h⁻¹)

Risø zone	Location	nSv h ⁻¹
I	1	35
I	2	46
I	3	79
I	4	-
I	5	57
Mean		54
II	P1	42
II	P2	63
II	P3	68
II	P4	51
Mean		56
III	P1	56
III	P2	57
III	P3	53
Mean		55
IV	P1	39
IV	P2	38
IV	P3	50
IV	P4	51
IV	P5	42
IV	P6	43
IV	P7	50
Mean		45
V	P1	49
V	P2	55
V	P3	54
V	P4	40
V	P5	60
V	P6	50
V	P7	45
V	P8	61
V	P9	61
V	P10	61
Mean		54

Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) July - December 2012. Measured with a NaI(Tl) detector. (Unit: nSv h^{-1})

Risø zone	Location	October
I	P1	41
I	P2	50
I	P3	366
I	P4	45
I	P5	75
Mean		116
II	P1	45
II	P2	45
II	P3	43
II	P4	43
Mean		44
III	P1	49
III	P2	50
III	P3	48
Mean		49
IV	P1	37
IV	P2	48
IV	P3	48
IV	P4	47
IV	P5	46
IV	P6	42
IV	P7	46
Mean		45
V	P1	43
V	P2	54
V	P3	55
V	P4	46
V	P5	50
V	P6	49
V	P7	40
V	P7a	46
V	P8	51
V	P9	53
V	P10	42
Mean		48

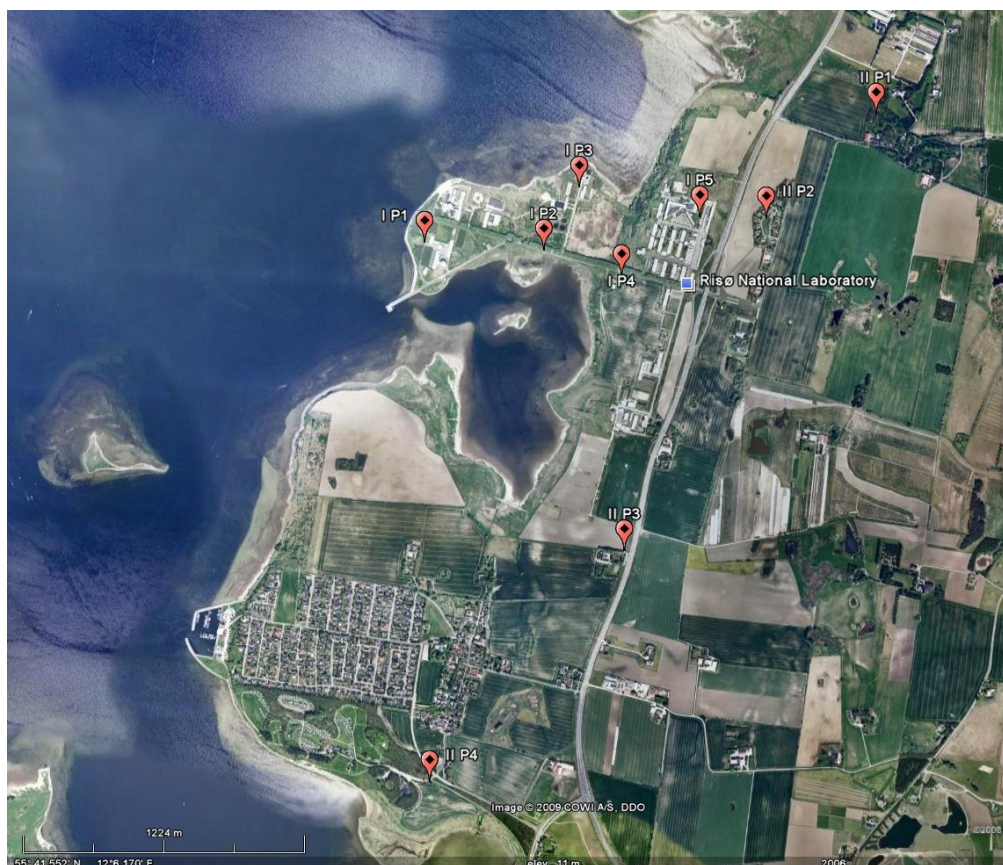


Fig. 1. Locations for measurements of gamma-background radiation Zone I and II (cf. Tables 8.2 and 8.3)

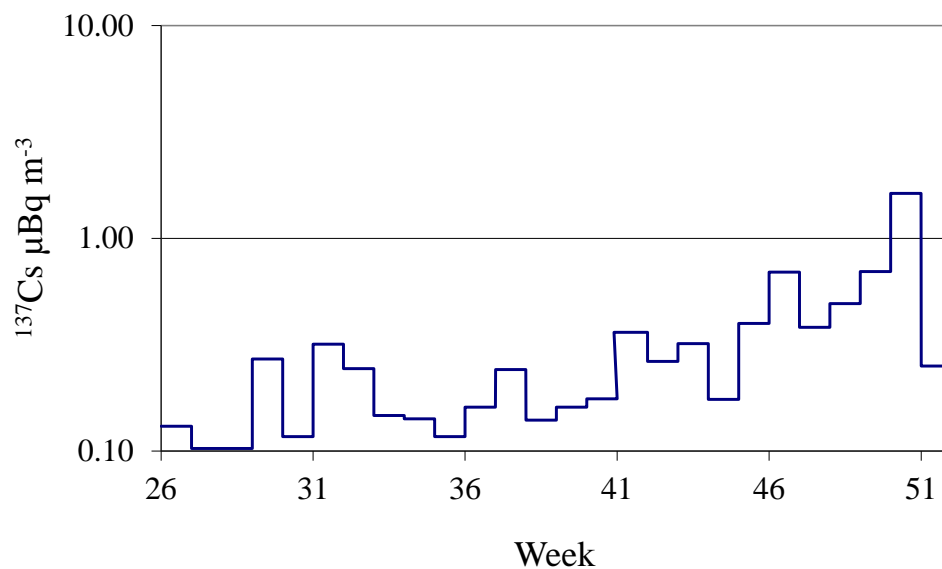


Fig. 1.1. Caesium-137 in ground level air collected at Risø in July-December 2012. (Unit: $\mu\text{Bq m}^{-3}$)

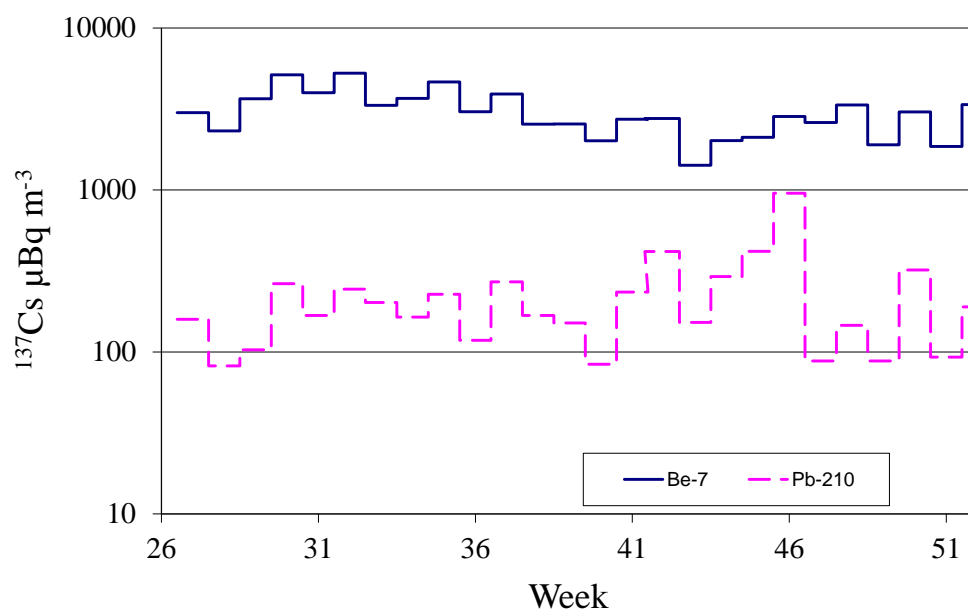


Fig. 1.2. Beryllium-7 and lead-210 in ground level air collected at Risø in July-December 2012. (Unit: $\mu\text{Bq m}^{-3}$)

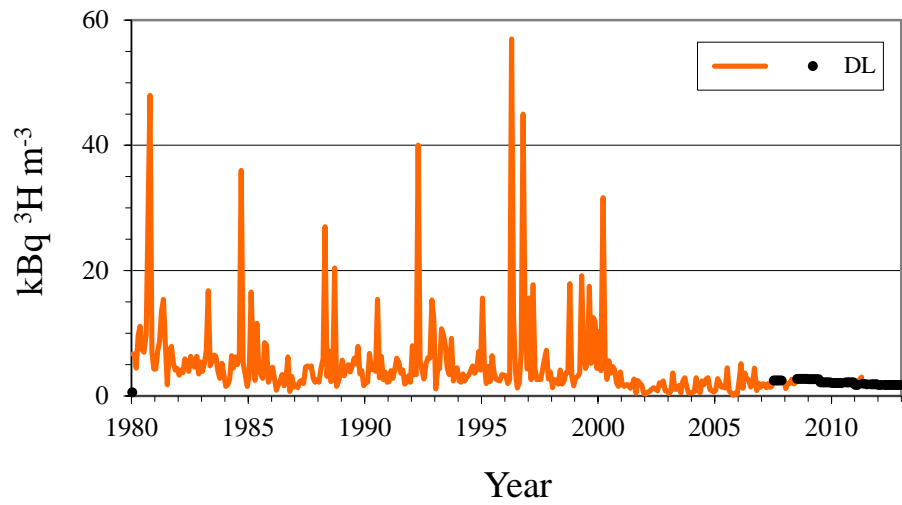


Fig. 2.3.1. Tritium in precipitation collected at Risø (1 m² rain collector) 1980 - 2012. (Unit: kBq m⁻³; DL = detection limit)

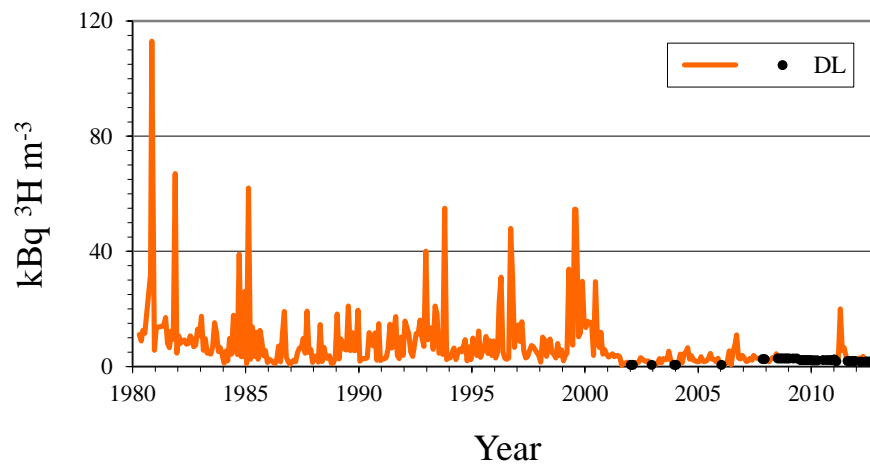


Fig. 2.3.2. Tritium in precipitation collected at Risø (10 m² rain collector) 1980 - 2012. (Unit: kBq m⁻³; DL = detection limit)

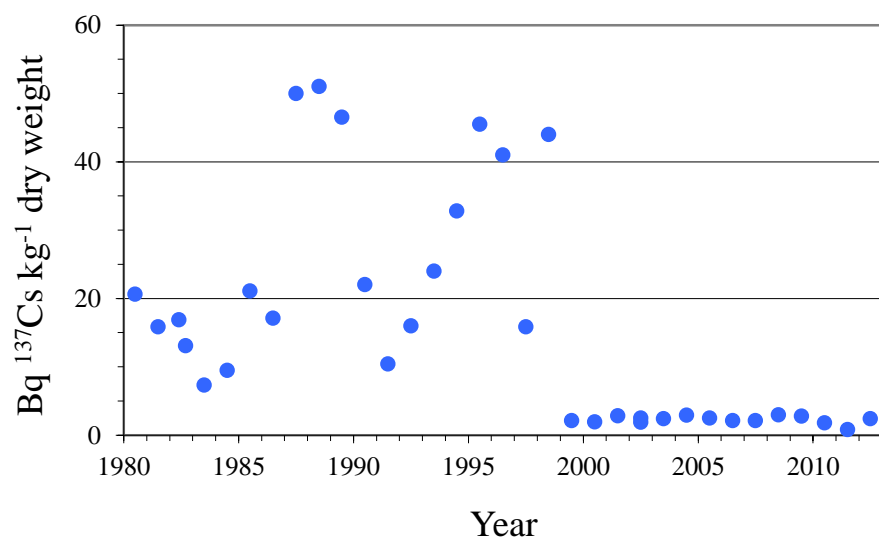


Fig. 3.1. Caesium-137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2012. (Unit: Bq kg^{-1} dry matter)

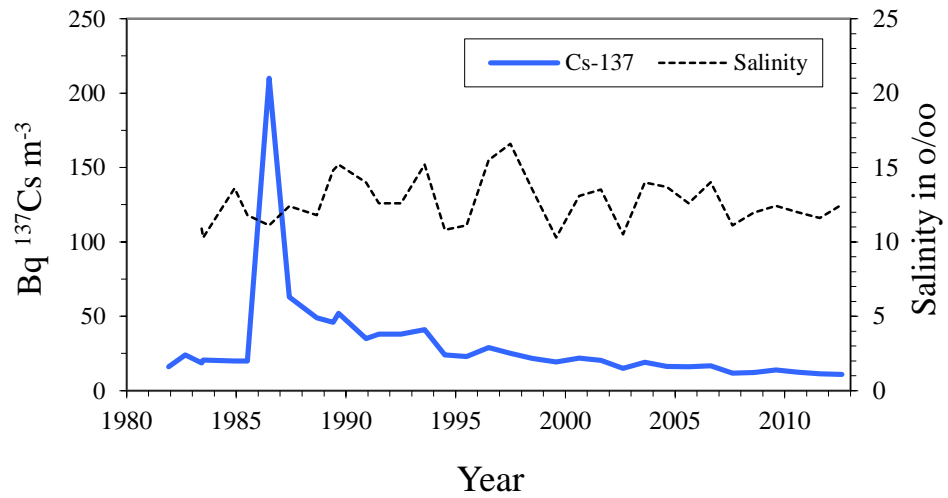


Fig. 4.1. Caesium-137 in seawater collected in Roskilde Fjord 1980 - 2012.
(Unit: $Bq\ m^{-3}$)

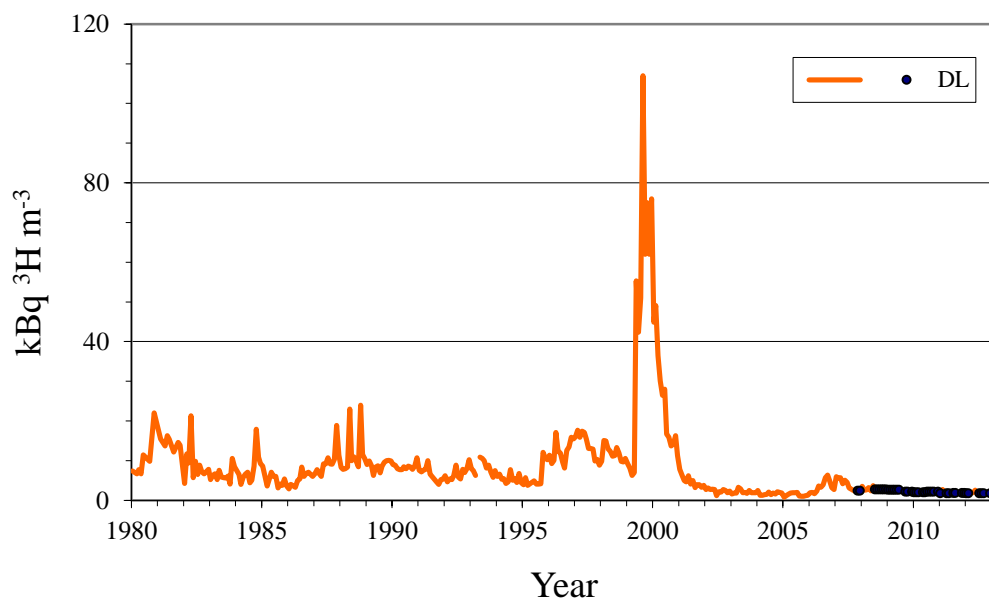
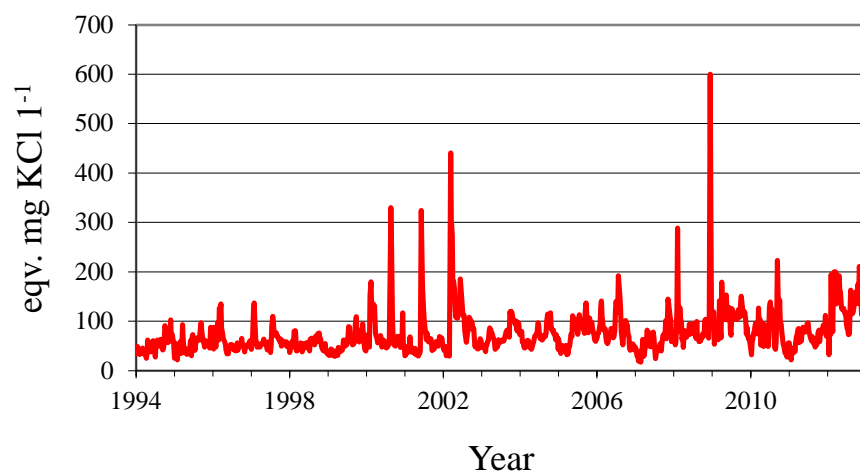


Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2012.
(Unit: $kBq\ m^{-3}$; DL = detection limit)



*Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2012.
(Unit: eqv. mg KCl l⁻¹)*

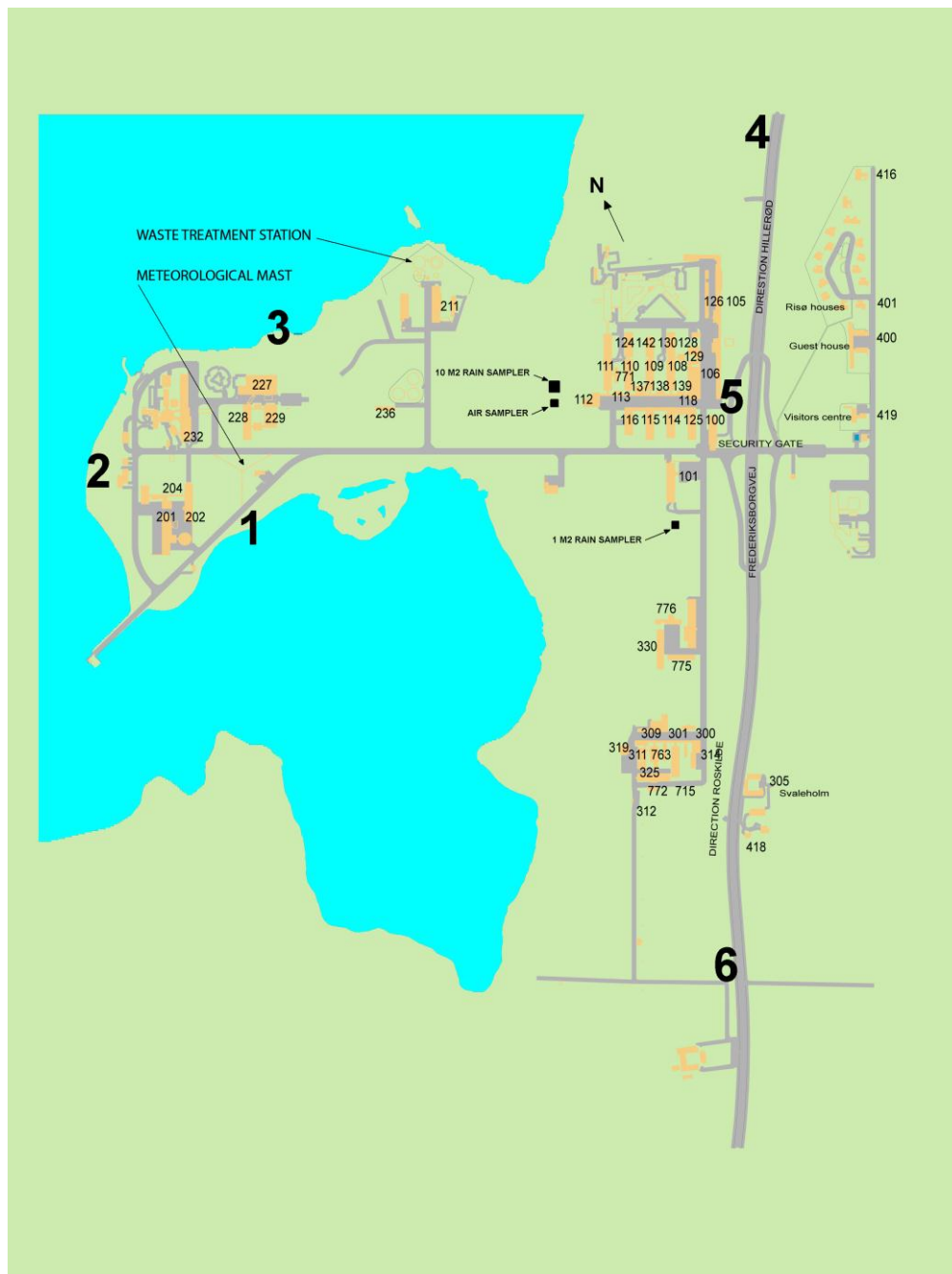


Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).

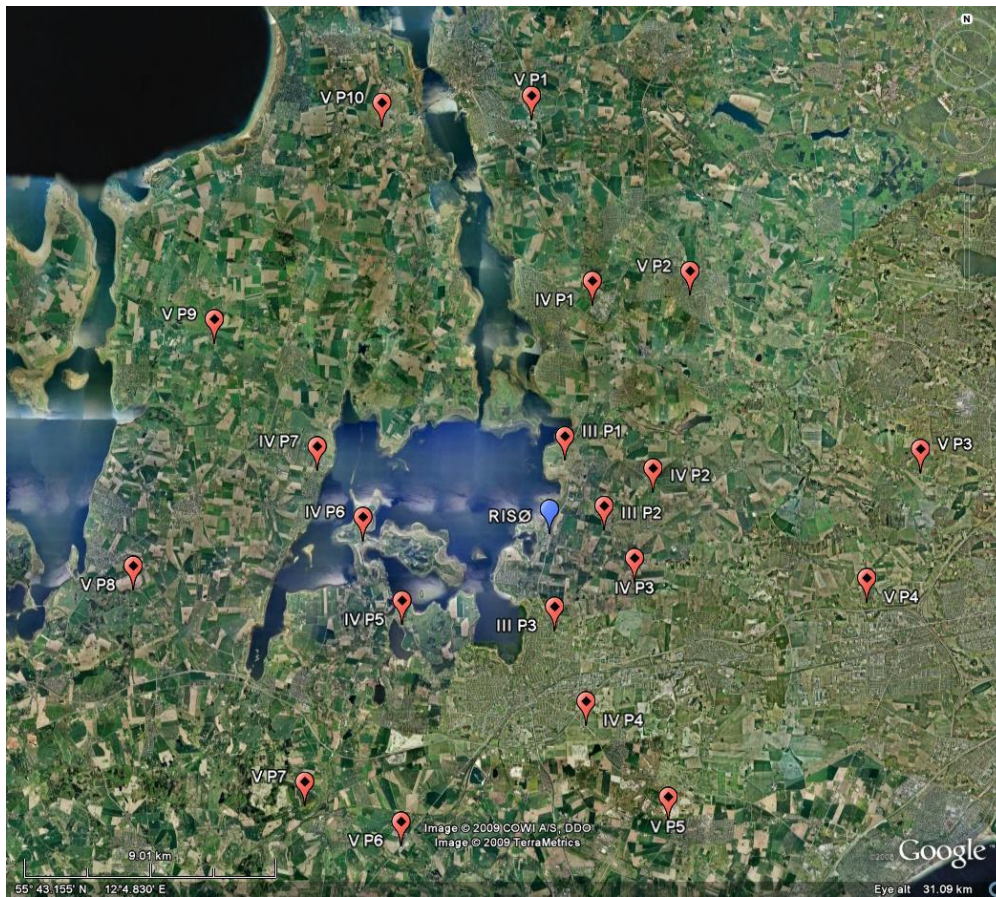


Fig. 8.2. Locations for measurements of background radiation around Risø in Zones III, IV and V.

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